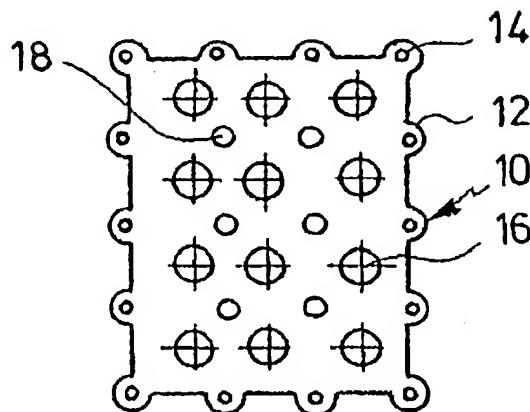


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(54) **DISPOSITIFS DE SUPPORT POUR LA COLONNE
VERTEBRALE DES HUMAINS**
(54) **SUPPORTING MEANS FOR THE HUMAN SPINE**



(57) Dispositif d'appui servant à corriger et/ou stabiliser les vertèbres blessées ou fragilisées d'une colonne vertébrale humaine, notamment les vertèbres cervicales. Le dispositif est composé d'une plaque constituée d'un matériau déformable et compatible avec le corps humain, laquelle est destinée à être fixée sur la face antérieure d'au moins deux vertèbres adjacentes. La plaque présente des trous à vis pour ostéosynthèse, lesquelles sont vissées dans les vertèbres. Il est possible de modeler la plaque selon le contour des vertèbres en affaiblissant certaines zones de la plaque et/ou en sélectionnant des plaques de différentes épaisseurs et/ou de matériau différent. Les zones affaiblies peuvent être constituées de nombreux trous, de préférence circulaires, ayant un diamètre inférieur à celui des trous à vis.

(57) Sustaining means for correcting and/or stabilizing injured or deficient vertebrae of the human spine, in particular of the cervical vertebra region, comprises a plate made of deformable, body-compatible material to be attached anteriorly to at least a pair of adjacent vertebrae. The plate has holes for receiving bone screws to be screwed in the vertebrae and is formed, by weakening zones and/or by selecting the thickness and/or selecting the material, to match the contour of the vertebrae. The weakening zones may consist of a plurality of preferably circular holes of diameter smaller than the diameter of the screw holes.



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ABSTRACT

Sustaining means for correcting and/or stabilizing injured or deficient vertebrae of the human spine, in particular of the cervical vertebra region, comprises a plate made of deformable, body-compatible material to be attached anteriorly to at least a pair of adjacent vertebrae. The plate has holes for receiving bone screws to be screwed in the vertebrae and is formed, by weakening zones and/or by selecting the thickness and/or selecting the material, to match the contour of the vertebrae. The weakening zones may consist of a plurality of preferably circular holes of diameter smaller than the diameter of the screw holes.

The present invention relates to a sustaining means for correcting and/or stabilizing injured or deficient vertebrae of the human spine.

German petty patent 87 11 317 discloses so-called Schanz screws which are screwed in the vertebra through the pedicels to reposition healthy and/or fractured vertebrae. The Schanz screws are secured to a sustaining means which provides an adjustment of the Schanz screws with respect to all three degrees of freedom.

The known sustaining means, however, are not able to bridge more than a vertebra or to provide for a multi-segmental treatment of multiple fractures. To provide for an implantation, the Schanz screws must be cut off after securing to the sustaining means. Consequently, burs are formed at the end of the screws. Due to the need of substantial space, the known sustaining means may not be used in the upper range of the spine, in particular in the cervical vertebra zone.

A number of vertebrae may be bridged by a so-called Harrington rod to which hooks or pedicel screws are attached. However, a Harrington rod cannot be individually adjusted to the particular shape of the spine in the zone where it is applied. Therefore, it has been known to use a threaded wire cooperating with pedicel screws. This known sustaining means, however, does not provide a primary stable support because it exhibits non-sufficient strength. Therefore it can be used mainly for spines which are stable per se and of which the course has to be corrected for orthopedic reasons.

German petty patent 88 02 112 discloses a sustaining means for the human spine, wherein between adjacent pedicel screws a tension jack is provided which ends include clamping faces for clamping to the head of a pedicel screw. By adjusting the axial distance of the bolts with respect to each other, for example by means of a threaded sleeve, the attachment points of the pedicel screws may be adjusted. Still further the bolts provide for a rotation of the pedicel screws about the bolt axis at a desired angle. Furthermore, the pedicel screws may be pivoted about an axis normal to the axis with respect to the attachment points to be fixed in a desired position. The pedicel screw may thus take any desired position in space and can be fixed in this position. The known sustaining means provides for screwing pedicel screws into each desired vertebra to fix desired vertebrae of a spine portion with respect to each other. The sustaining means described is thus suited to primarily stabilize the spine, when one or more vertebrae are fractured. However, even this sustaining means which is dorsally implanted, which means a relatively small stress to the patient is not suited to be used for the upper spine zone, in particular for the cervical vertebrae.

Accordingly, the invention is based on the object to provide a sustaining means for the correction and/or stabilization of injured or deficient vertebrae of the human spine, which may be used in the upper zone of the spine.

According to the invention there is provided a spinal support plate for attachment to at least a pair of adjacent vertebrae

of the spine, said plate having a longitudinal axis adapted to be parallel to the longitudinal axis of the spine when the plate is attached to adjacent vertebrae, said plate comprising: at least three rows of three holes each for receiving bone screws of a predetermined diameter, each of said rows aligned along an axis perpendicular to said longitudinal axis of said spinal support plate; and at least two additional rows of at least two smaller diameter holes each, said holes in said additional rows having a diameter 10 smaller than said predetermined diameter and smaller than the diameter of said holes for receiving said bone screws, said rows aligned along an axis perpendicular to said longitudinal axis of said spinal support plate, said at least two rows of smaller diameter holes located between adjacent rows of said holes for receiving said bone screws.

According to the invention the plate is suited to be pre-shaped before the operation to conform to the contour of the vertebrae or to be shaped by the surgeon right during the operation. Thereafter, the plate is fixed by bone screws to the vertebrae whereby screw holes are formed substantially in the center axis of the plate and additionally towards the edge which is bent in the longitudinal axis to fit to the vertebra. To fit the plate to the depressions in the vertebra, the plate is further bent around a normal axis so that the plate obtains a substantial stability due to the different bending which stability is sufficient for a primary setting of fractured or deficient vertebrae, for example.

Attaching the plate is performed anterior, i.e. from the front side so that it is particularly suited for the cervical vertebrae of the spine. The attachment does not involve particular problems and needs extremely little space thus being less detrimental to the patient. The bone screws are either anchored in the vertebra only or additionally in the pedicels of the vertebrae or in the pedicels exclusively.

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The plate of the invention must represent a sufficient deformability on the one hand and a sufficient stiffness on the other. According to the invention a weakening of the plate to facilitate deformability is provided by the rows of smaller, preferably round, holes. A weakening of this type is relatively easy to manufacture. Therefore, a further embodiment of the invention provides to arrange the screw holes or the weakening zones of the plate and thus of the

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1 smaller holes such that the plate is stiffer in its central
longitudinal zone than towards the longitudinal edge.
Therefore, the plate may be more easily deformed along the
5 length edge than towards the central portion which feature
facilitates fitting the plate to the contour of the
vertebras.

10 To prevent weakening the plate too much, the number of
holes should be limited. According to an embodiment of the
invention, the distance or the multiple of the distance of
the screw holes in the length axis of the plate substan-
15 tially corresponds to the center distance of adjacent ver-
tebras, possibly taking into account the shaping along a
normal axis or length axis to fit to the contour of the
vertebras. Particularly in the cervical vertebra range the
bone screws are more easily screwed centrally in the
vertebra than in the lower or upper range.

20 The length of the plate depends on the size of the injured
range. Possibly a plate covering two vertebrae is suffi-
cient. However, as the case may be, the length of the plate
may be selected substantially larger. To prevent preparing
25 an individual plate for each length, the invention provides
for an endless plate which may be cut. Thus, the surgeon may
determine the length of the plate which is cut from a suit-
able stock.

30 According to a further embodiment of the invention the screw
holes in the end areas of the plate are elongated tapering
towards the end thereof to become more narrow and the edges
of the holes are sloped to cooperate with the conical under-
35 side of the screw head. In this way a compression force may
be created when the conical undersides of the screw heads
cooperate with the elongate holes.

1 A further embodiment of the invention provides ear-like projections along the edges of the plate including small holes. The holes may accomodate wires, for example to obtain an additional fixing.

5 Various embodiments of the invention are described in more details in referring to the drawings.

10 Fig. 1 a top view of a first embodiment of a schematically illustrated plate according to the invention,

15 Fig. 2 show a top view of a second embodiment of the invention,

16 Fig. 3 shows a section through Fig. 2 along lines 3-3,

Fig. 4 shows a top view of a third embodiment of the invention and

20 Fig. 5 shows a top view of a fourth embodiment of a plate according to the invention.

25 Fig. 1 shows a plate 10 made of flat material of a body-compatible material, for example titane. Along the edges and at the corners the plate 10 comprises small ear-like projections 12 including including small circular holes 14. The plate 10 further comprises four lines of screw holes 16 to receive bone screws. Smaller circular holes 18 are formed between the screw holes 16. The distance of the screw holes 16 in the lines approximately corresponds to the central distance of adjacent cervical vertebrae, for example. By the individual holes and/or the selection of material, the plate 10 is suited to more or less closely fit to the contour of cervical vertebrae. The shaping may be performed before the operation or during the operation. By means of

1 bone screws not shown the plate 10 is then fixed to adjacent
vertebras, wherein a part only of the screw holes is used. A
wire used for an additional fixing may be pulled through the
holes 14 in the ear-like projection 12.

5 The plate 20 of Fig. 2 is of similar structure as the plate
10 of Fig. 1. Alike, it comprises ear-like projections 12a
including holes 14a and lines of screw holes 16a and smaller
holes 18a therebetween. Furthermore, elongated holes 22 are
10 provided in a predetermined distance, which are narrowed
towards the end of plate 20. The edge of the holes 22 is
conical, as Fig. 3 shows so that by means of a conical screw
head a compression may be exerted on the vertebra in which
the screw in the elongated holes 22 are screwed in. The
15 plates 20 may be made of an endless material as indicated at
24 and from this material a desired length is cut off, in
particular by the surgeon.

20 Fig. 4 shows vertebrae 24 of cervical vertebrae which are
connected to each other by a plate 26. The structure of the
plate 26 corresponds to the plate 10 of Fig. 1, i.e. the
plate comprises rows of screw holes 16b and rows of holes
18b having a smaller diameter to facilitate shaping. The
25 plate 26 is bent along its length axis, in particular in the
edge zone and in addition thereto along its normal axes to
better fit to the outer contour of the vertebrae 24. Only
the screw holes 16b located in the center of the vertebrae
24 accommodate bone screws 28.

30 The plate 30 shown in Fig. 5 is provided with rows of screw
holes 16c wherein rows with three screw holes 16c alternate
with rows of two screw holes 16c. The distance between the
rows with three screw holes 16c or, respectively between the
rows with two screw holes 16c approximately corresponds
35 again to the center distance of adjacent vertebrae of the
cervical spine. Between the screw holes, rows of through

1 holes 18c of smaller diameter are provided. One realizes,
that by providing the screw holes 16c, the plate 30 is
stiffer in its central region than towards the longitudinal
edges. This is augmented by selecting the distance of both
5 the central holes 18c larger than between a central and an
outer hole 18c of the row. Thus, a relatively high ducti-
bility is obtained in the edge zone, whereas the central
region is substantially stiffer.

10 Preferably, the plate 30c is made endless so that the
surgeon cuts off a suitable length.

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THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A spinal support plate for attachment to at least a pair of adjacent vertebrae of the spine, said plate having a longitudinal axis adapted to be parallel to the longitudinal axis of the spine when the plate is attached to adjacent vertebrae, said plate comprising:

at least three rows of three holes each for receiving bone screws of a predetermined diameter, each of said rows aligned along an axis perpendicular to said longitudinal axis of said spinal support plate; and

at least two additional rows of at least two smaller diameter holes each, said holes in said additional rows having a diameter smaller than said predetermined diameter and smaller than the diameter of said holes for receiving said bone screws, said rows aligned along an axis perpendicular to said longitudinal axis of said spinal support plate, said at least two rows of smaller diameter holes located between adjacent rows of said holes for receiving said bone screws.

2. A support plate according to claim 1 wherein one of said screw holes in each row is located substantially along said longitudinal axis, said one of said screw holes in each row being spaced apart at a distance which corresponds substantially to the distance between adjacent vertebrae.

3. A support plate as set forth in claim 1 wherein ear-like projections extend from the edges of said plate, said

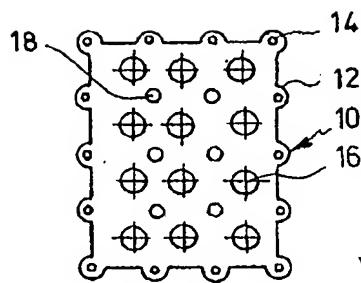
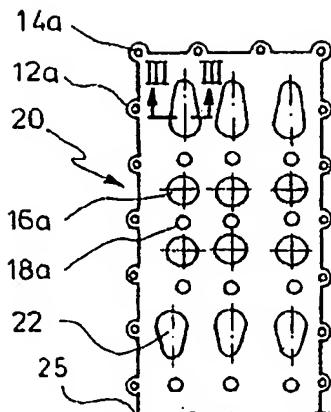
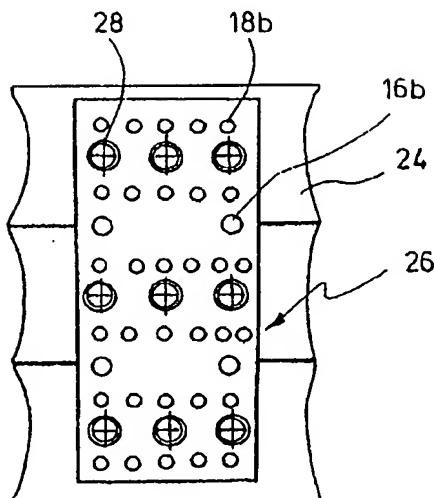
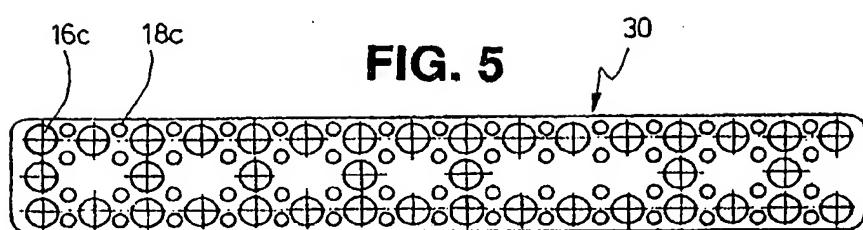
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projections including holes, said holes aligned with said axis of said rows of smaller diameter holes.

4. A support plate as set forth in claim 1 wherein one of said bone screw receiving holes in each row is located on said longitudinal axis.

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**FIG. 1****FIG. 2****FIG. 4****FIG. 3****FIG. 5**

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